OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52378315 Date 11/13/10 Initials CW Region (A B C D)

Site _____ Location Chapel Lane over Canyon Lake

Q_{100} = 2230 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 2230 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 122 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20°

Width (W_2) iteration = ~Vert Abut

Avg. flow depth at bridge, y_2 iteration = _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114.64 ft* $q_2 = Q_2/W_2$ = 19.5 ft²/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 3.7 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.2 ft + 0.8' for Δws over weir = 5.0'

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = — ft

Low Steel Elev. = 10.7 ft

n (Channel) = 0.045

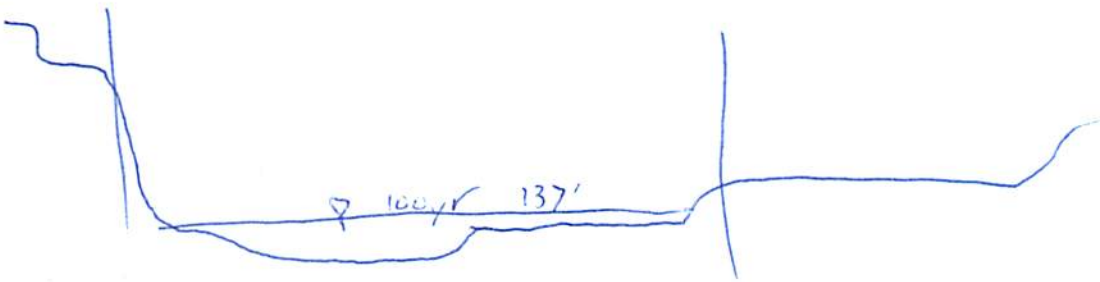
n (LOB) = 0.075

n (ROB) = 0.075

Pier Width = — ft

Pier Length = — ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 137 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) 2=0

Estimated bed material D_{50} = 0.5 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~11.26~~ 3 3.88 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ~~11.59~~ 11.26 ft/s

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.0159~~ .029 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = — From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

Froude # at bridge = _____ Using pier width a on Figure 11, ξ = _____ Pier scour y_{ps} = _____ ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52378315 Date 11/13/10 Initials CW Region (A B C D)

Site _____ Location Chapel Lane over Canyon Lake

Q_{500} = 12300 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. _____

Bridge discharge (Q_2) = 12300 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 122 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = ~ Vert Abut

Avg. flow depth at bridge, y_2 iteration = _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114.64 ft* $q_2 = Q_2/W_2$ = 107.3 ft²/s

Bridge Vel, V_2 = 11.5 ft/s Final $y_2 = q_2/V_2$ = 9.3 ft Δh = 2.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.1 ft +0.8 = 12.9'

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = — ft

Low Steel Elev. = ~~10.2~~ 10.2 ft

n (Channel) = 0.045

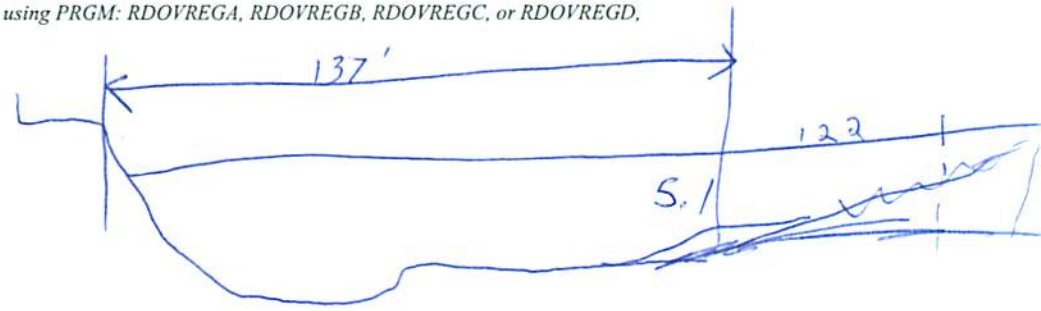
n (LOB) = 0.075

n (ROB) = 0.075

Pier Width = — ft

Pier Length = — ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 137 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 122 ft Average right overbank flow depth, y_{rob} = 5.1 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) Z = 0

Estimated bed material D_{50} = 0.5 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~6.96~~ ft/s 3.92 ~~3.92~~ 3.68

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 13.54 ft/s ~~13.53~~ ~~13.58~~ 13.43

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.646~~ 0.12 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = — From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

Froude # at bridge = _____ Using pier width a on Figure 11, ξ = _____ Pier scour y_{ps} = _____ ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 5.1 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0 and ψ_{RT} = 15.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 27.6 ft

11/13/10

Route Chapel Ln Stream Rapid Creek MRM _____ Date _____ Initials CL

Bridge Structure No. 52378315 Location Chapel Lane over Canyon Lake

GPS coordinates: N 44° 03' 35.7" W 103° 17' 42.3" taken from: USL abutment____ centerline of ☐ MRM end _____

Datum of coordinates: WGS84____ NAD27____

Drainage area = 396.84 sq. mi.

The average bottom of the main channel was 20.0 ft below top of guardrail at a point 32 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓ drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2230			Q_{500} = 12300		
Estimated flow passing through bridge	2230			12300		
Estimated road overflow & overtopping	—			—		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X			X	
Chance of Pressure flow		X			X	
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? ____Yes X No ____Don't know

Debris Potential? X High ____Med ____Low

Does scour countermeasure(s) appear to have been designed?

Riprap ____Yes ____No ____Don't know X NA

Spur Dike ____Yes ____No ____Don't know X NA

Other _____ ____Yes ____No ____Don't know X NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay____	Sand____	Gravel____	Cobbles X	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Weir ~10 ft us from bridge will have to add ΔWS elev to approch XS

Not sure if Level 1.5 Method is valid on this bridge.

Photos
1464- ID
65- us
66- us RB
67- us LB
68- us Face bridge
69- LB of App XS
70- RB of App XS
71- R. Abut
72- L. Abut
73- Weir us from bridge
74- Bed Material
75- Weir
76- Weir

Summary of Results

	Q100	Q500
Bridge flow evaluated	2230	12300
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	5.1
Contraction scour depth (ycs), in feet	0.6	0.0
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	27.6
1Flow angle of attack	20	20°

See Comments/Diagram for justification where required